Homework 1

Problem 1

On pages 5 and 6 of lecture slide "fp_cancellation.pdf", we introduced two methods for calculating Heron's Formula:

- Method 1:
$$\sqrt{s(s-a)(s-b)(s-c)}, \text{ where } \quad s = \frac{a+(b+c)}{2} \tag{1}$$
- Method 2:
$$\frac{\sqrt{(a+(b+c))(c-(a-b))(c+(a-b))(a+(b-c))}}{4}. \tag{2}$$

Let $a = 9.00$ and $b = c = 4.53$ and assume that we are using a floating-point system with precision $p = 3$.

(a) Show that the area A is calculated to be 3.04 using (1). Note that for each multiplication and square root, we assume the exact calculation is first done, and the result are then rounded.

(b) Show that the area A is calculated to be 2.35 using (2).

(c) Following the previous two subproblems, if compared to the (roughly) true value $A = 2.342$, what are the errors in ulps using formula (1) and (2), respectively?

Problem 2

In this problem, we explore another example of catastrophic cancellation. Check Eq. (13) of the following paper and lines 213-216 in tron.cpp from the software package LIBLINEAR version 2.11. Explain how we avoid catastrophic cancellations.

- Paper: `http://www.csie.ntu.edu.tw/~cjlin/papers/logistic.pdf`
- LIBLINEAR version 2.11: `http://www.csie.ntu.edu.tw/~cjlin/liblinear/oldfiles`

Note: We do not consider the latest version of LIBLINEAR because this code segment has been removed.

Problem 3

Let us see another cancellation example. On page 5, line 12 of the paper

`http://www.csie.ntu.edu.tw/~cjlin/papers/plattprob.pdf`,

there are two methods to calculate $1 - p_i$, and the results produced by the two methods may differ under some conditions. Please write a short C++ program to reproduce the examples and discuss what you find. Include your code in the report.